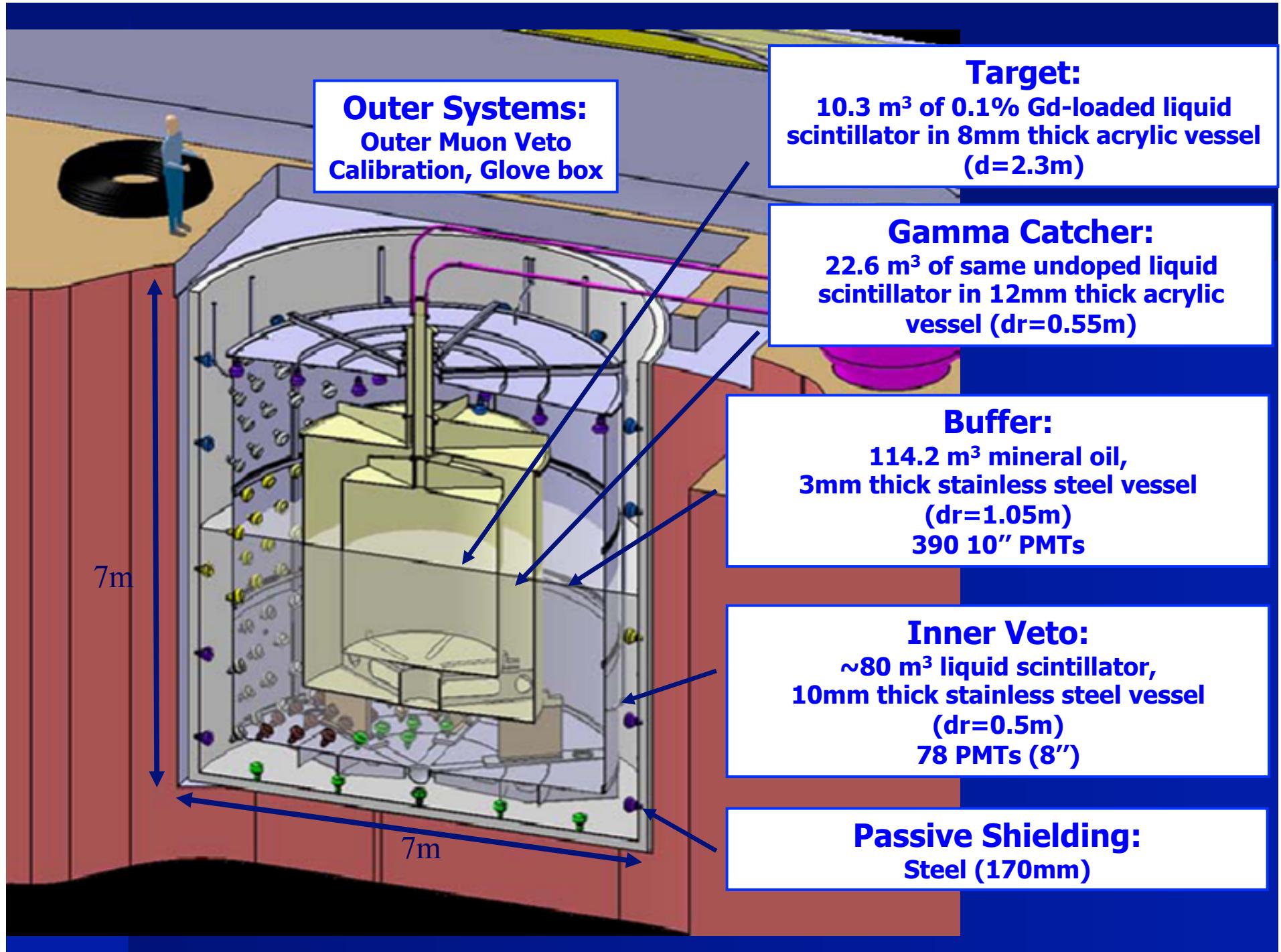


Double Chooz Calibration Activities at ANL

- responsible for calibration hardware
 - z-axis radioactive source deployment system for central axis calibration
 - articulated arm source deployment system for full detector calibration
- cosmogenics for early calibration before source deployments are possible
- lithium-9 production from stopped muons

Calibration Hardware

- IBD detection efficiency should be calibrated to 0.5%
- energy scale should be calibrated to 1% for γ , e^+ and to 20% for n's
- to do this, we need to deploy a variety of sources throughout the volumes of the detector
 - permanent tubes for gamma catcher and buffer volumes (Alabama and Saclay)
 - z-axis system for target central axis (ANL)
 - articulated arm for full target calibration (Drexel and ANL)



Outer Systems:
Outer Muon Veto
Calibration, Glove box

Target:
 10.3 m^3 of 0.1% Gd-loaded liquid scintillator in 8mm thick acrylic vessel
($d=2.3\text{m}$)

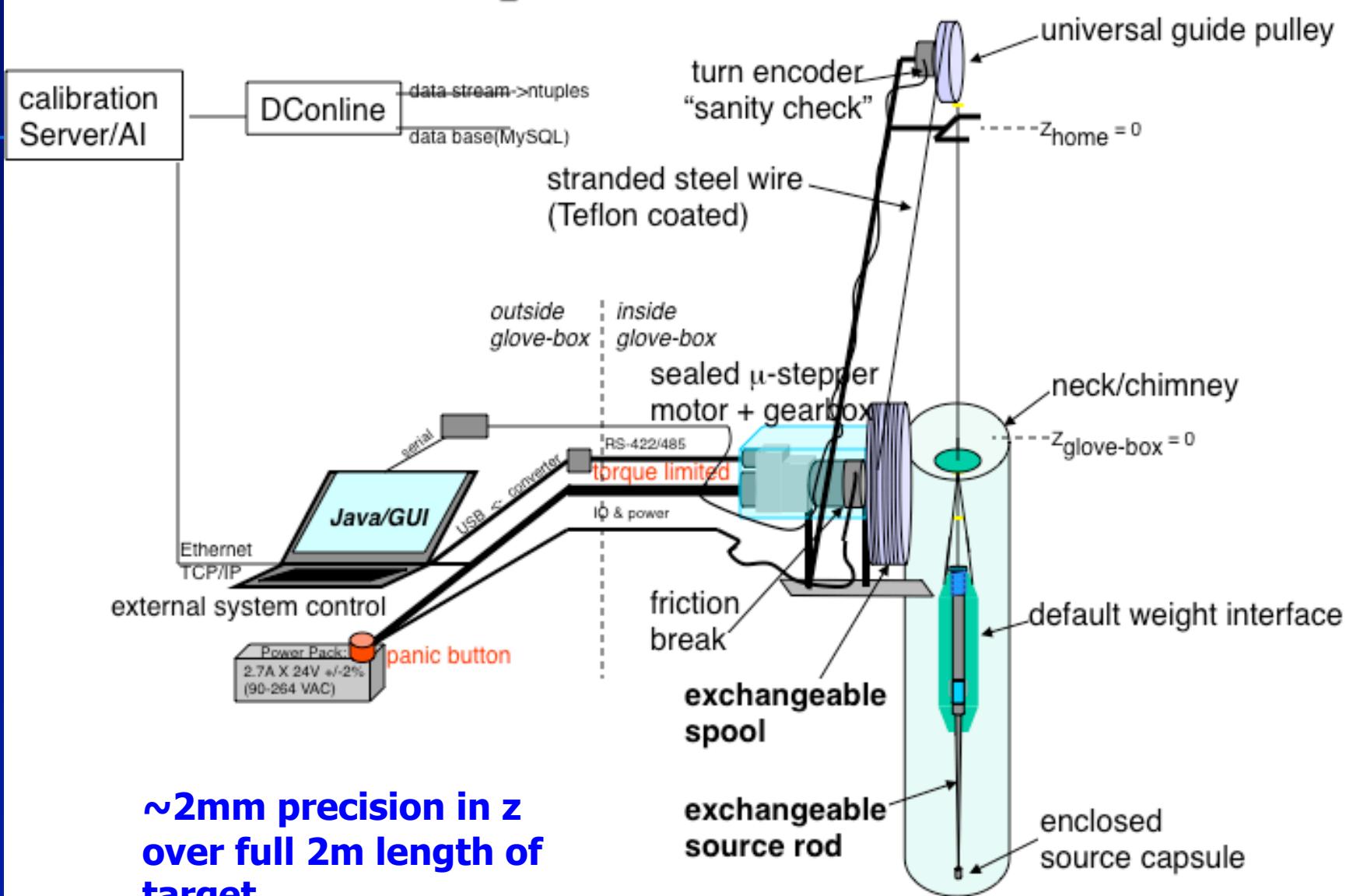
Gamma Catcher:
 22.6 m^3 of same undoped liquid scintillator in 12mm thick acrylic vessel ($dr=0.55\text{m}$)

Buffer:
 114.2 m^3 mineral oil,
3mm thick stainless steel vessel
($dr=1.05\text{m}$)
390 10" PMTs

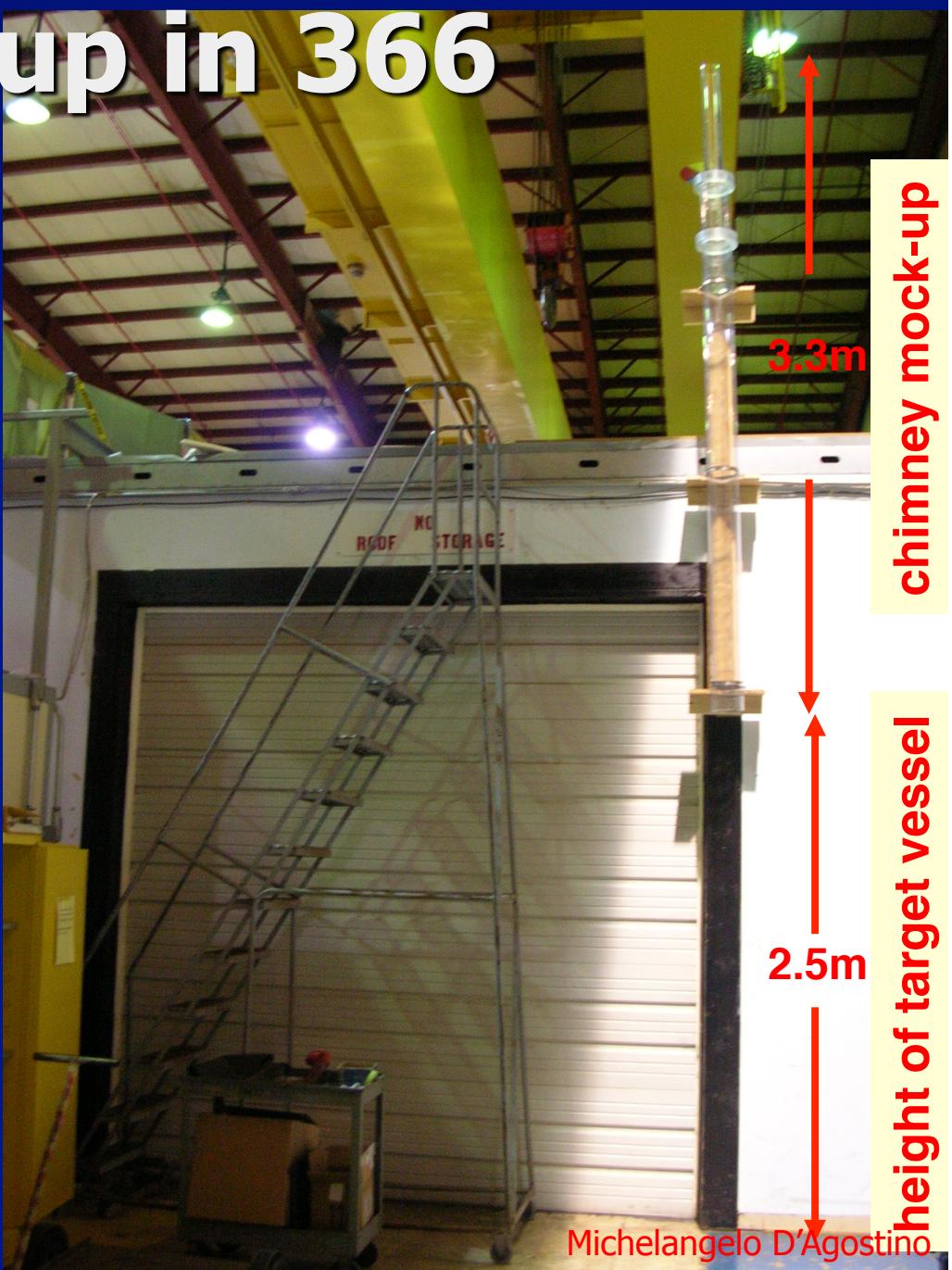
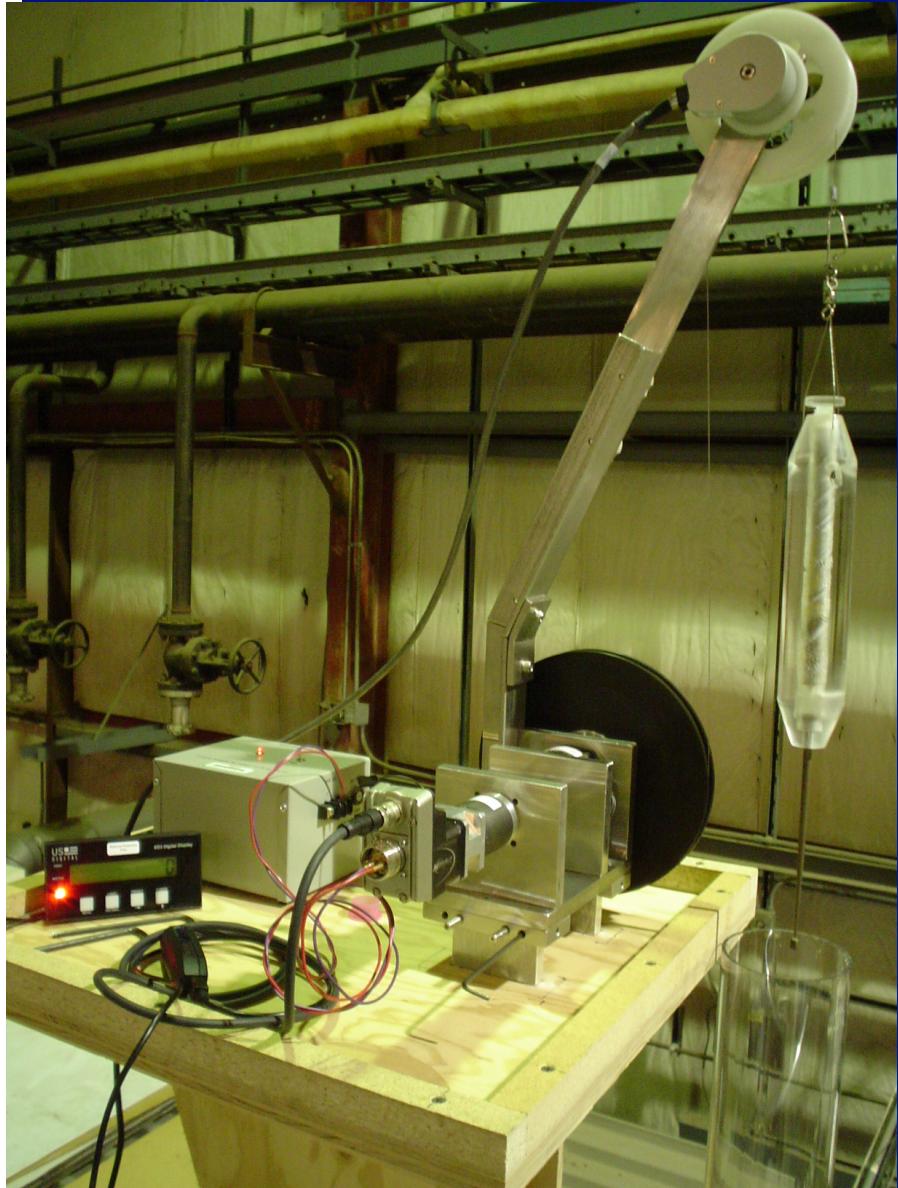
Inner Veto:
 $\sim 80 \text{ m}^3$ liquid scintillator,
10mm thick stainless steel vessel
($dr=0.5\text{m}$)
78 PMTs (8")

Passive Shielding:
Steel (170mm)

Z-Axis System



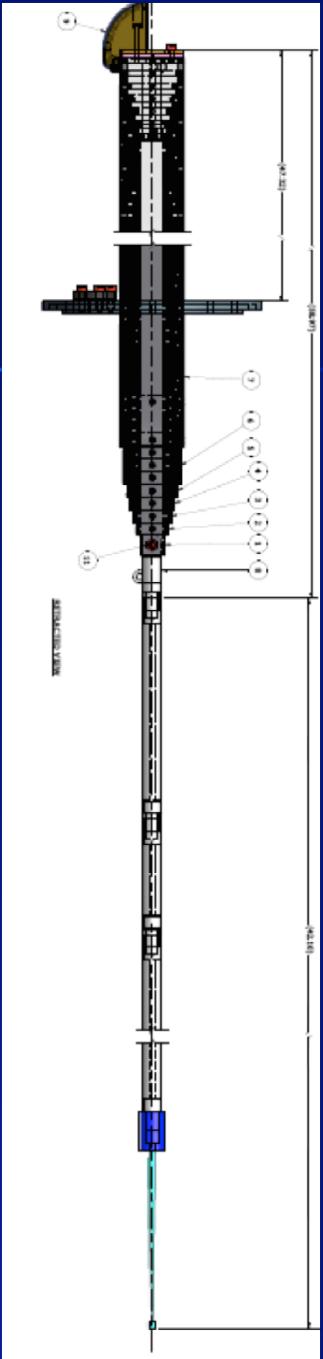
Chimney Mockup in 366



chimney mock-up

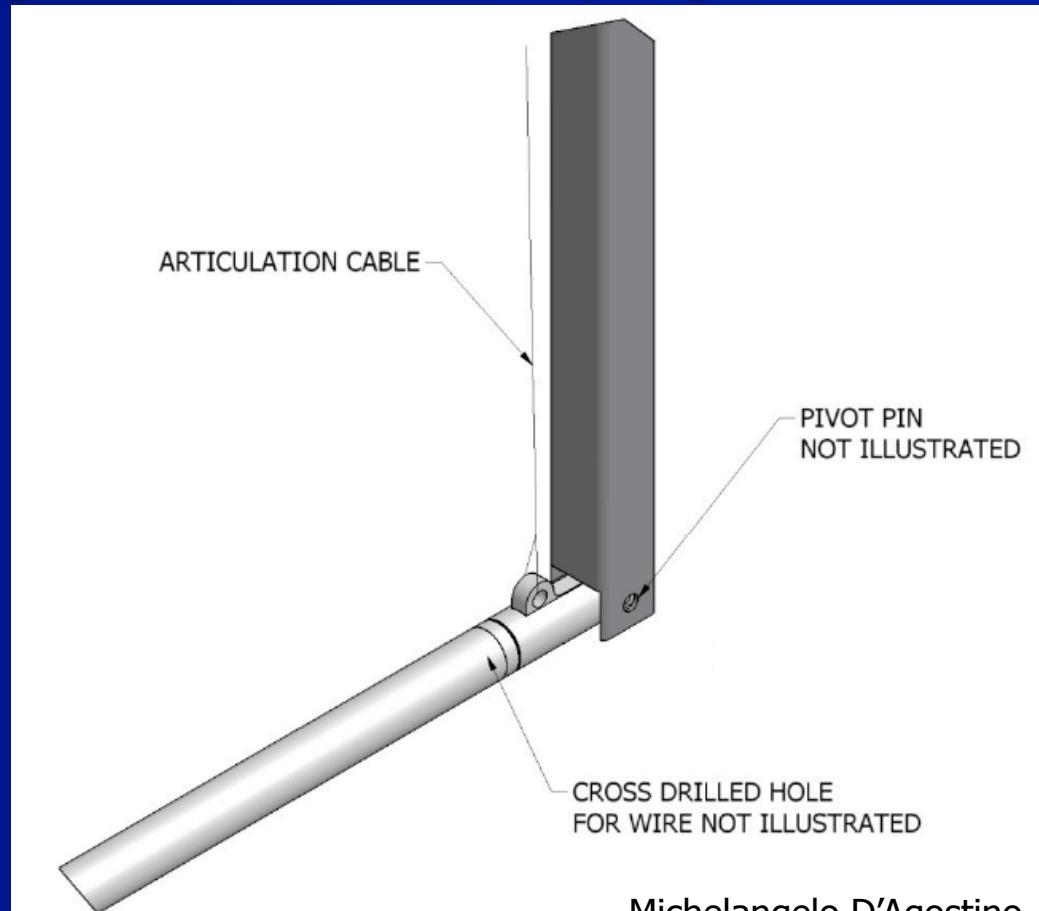
height of target vessel

Michelangelo D'Agostino

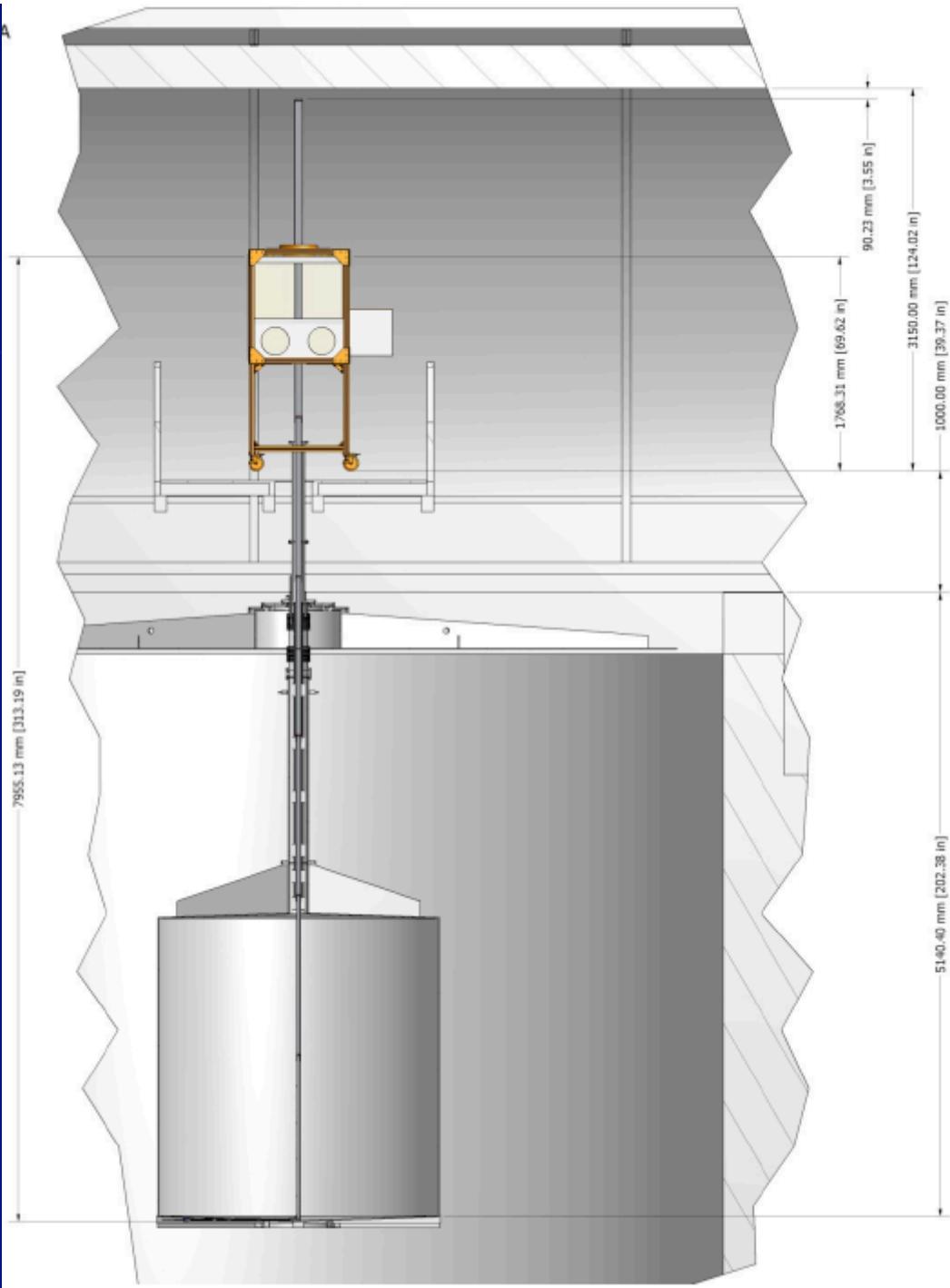


Articulated Arm

- Drexel is the responsible institution but design work, construction, and testing are being done at ANL through work for others program



Michelangelo D'Agostino



Michelangelo D'Agostino

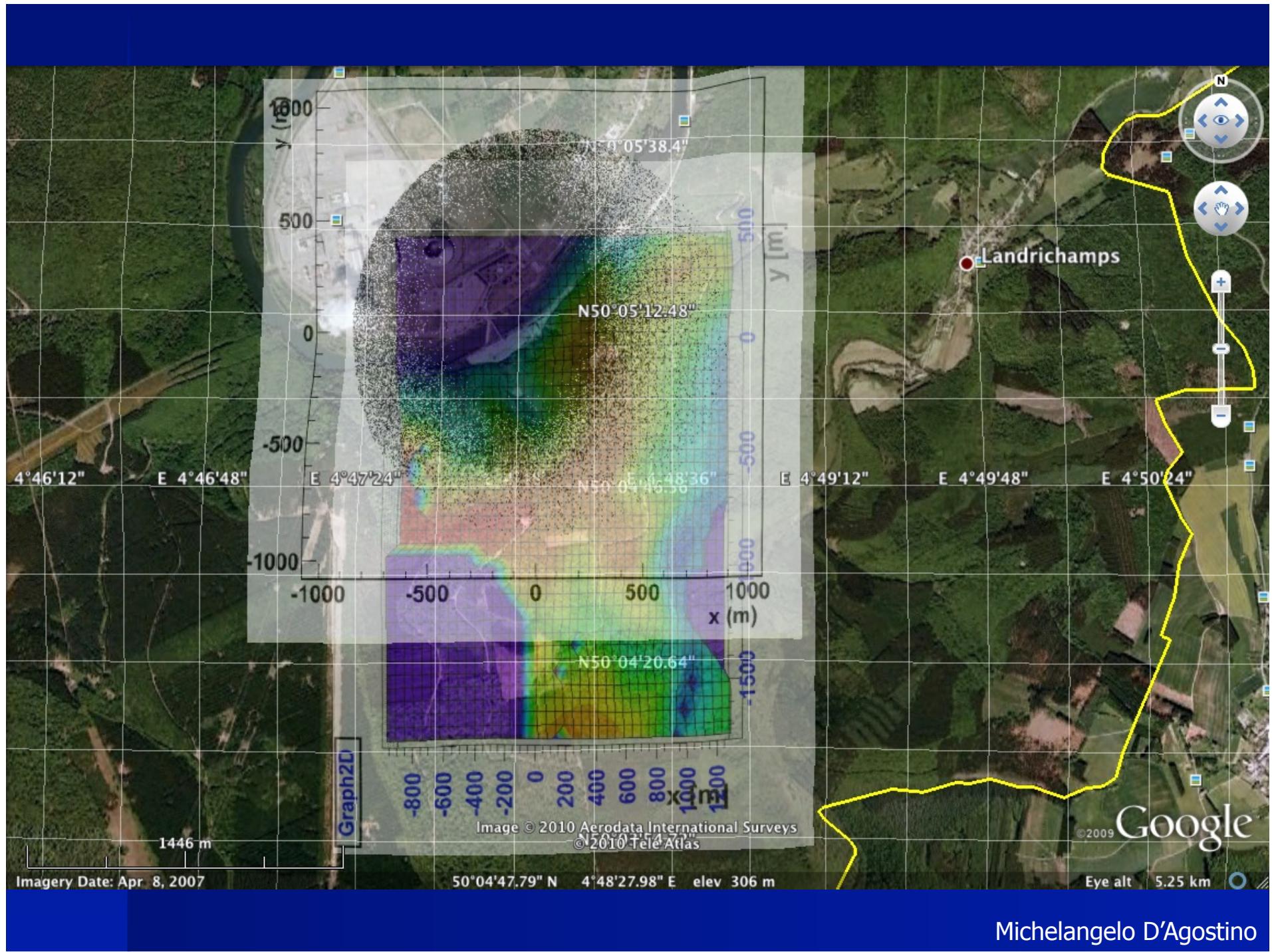
Cosmogenics

- boron-12: β^- emitter with $\tau = 20\text{ms}$ and endpoint of 13 MeV
 - produced in both muon spallation on carbon and stopped muon capture on carbon
 - ~70 events per day in target plus gamma catcher sensitive volumes
 - can be used for initial energy scale calibration and monitoring between deployments
- spallation neutrons can be used to monitor neutron energy scale, Gd concentration, leakage, etc. (Zelimir Djurcic)

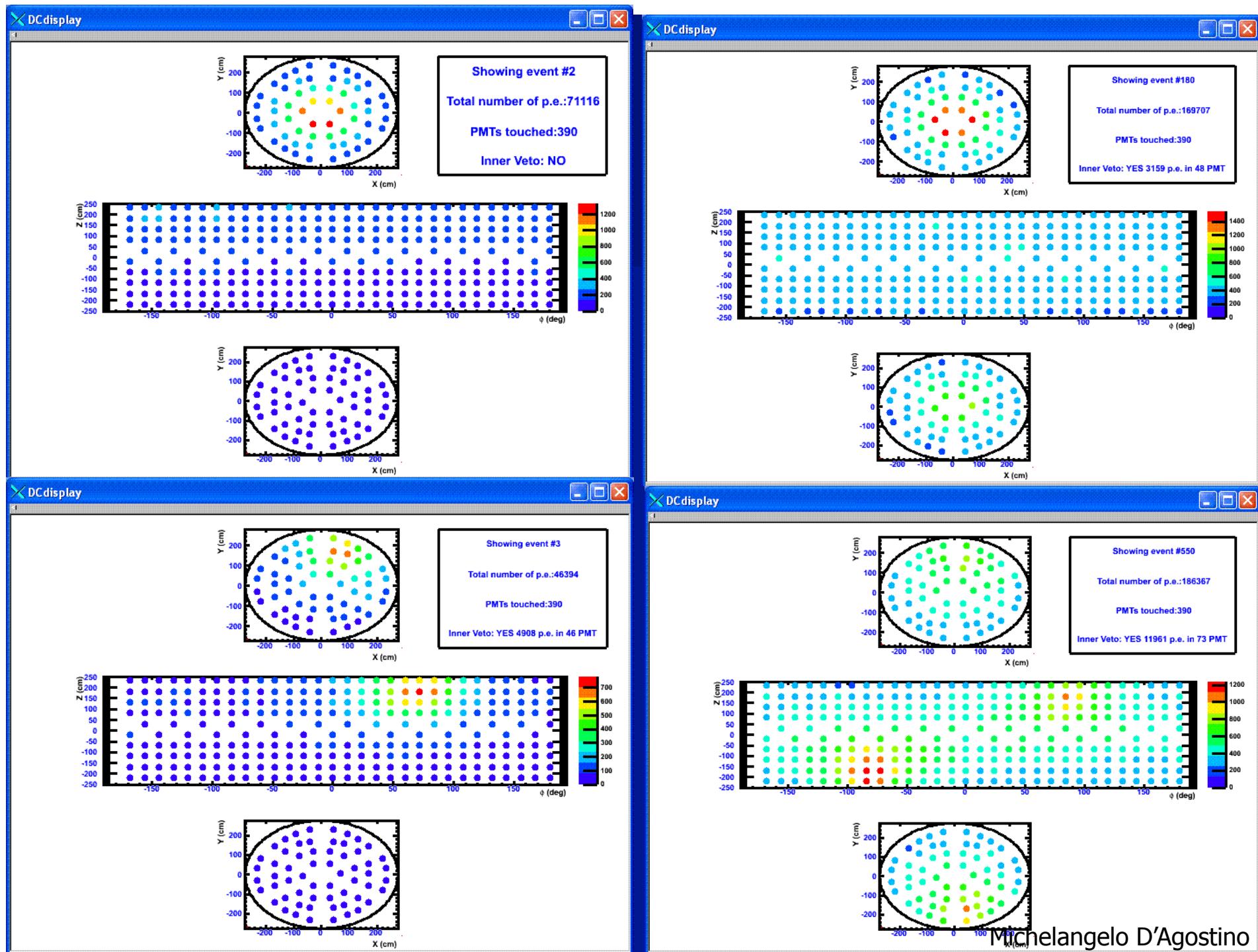
Cosmogenics

- the cross section for lithium-9 production in muon capture is completely unmeasured
 - important at shallower depth of near detector
- stopped muons are also a pernicious background for Double Chooz, so tagging them is important
- developed a new, faster muon simulation for Double Chooz with colleagues from UC Davis
- working now on stopping and throughgoing muon reconstruction and separation techniques

Michelangelo D'Agostino



Michelangelo D'Agostino



Other Activities

- software work on the I/O scheme for Double Chooz
- advising summer undergraduate students and graduate student on Double Chooz
- and of course...

Neutrino analysis soon!!